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Measuring Turbine Inflow with Vertically-Profiling Lidar in Complex Terrain

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Two Laser and Detection Ranging (lidar) units were deployed in the Altamont Pass region of California to study complex flow dynamics at a moderately complex terrain wind farm. The lidars provided wind measurements at the base and along the slope of a 140 m tall ridge and captured air flow as it moved up and along the ridge towards an unwaked turbine under varying stability conditions. Elevation enhanced wind speed during well-mixed or near-neutral conditions at the top of the ridge; however, the hill “speed-up” was smaller than expected during stable conditions. At these times the upwind terrain played a significant role in local flow variability as did terrain features within the wind farm. The observations were next analyzed to assess the ability of using vertically-profiling lidar in complex terrain to measure free-stream inflow for evaluating power generation response. Better agreement between the lidar wind speed and expected power was found once the lidar measurements had been adjusted for stability-dependent hill speed-up effects. This suggests that vertically-profiling lidar can be used in complex terrain to measure inflow if the terrain-induced flow features are also considered.

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